

PROXY FOR VIDEO ON DEMAND SERVER CONTROL

Related Application Data

The subject matter of this application is generally related to that disclosed in
5 the following applications filed contemporaneously herewith:

Video on Demand Methods and Systems (White et al);

Method and System for Presenting Television Programming and Interactive
Entertainment (White et al); and

Interactive Video Programming Methods (White et al).

10 The subject matter of this application is also generally related to the subject
matter of application 09/153,577, filed September 15, 1998.

The disclosures of these related applications are incorporated by reference.

Field of the Invention

15 The present invention relates generally to interactive entertainment systems,
and more particularly relates to the use of a processor between the head-end and
the clients, to which various processing tasks can advantageously be delegated.

Background and Summary of the Invention

20 The popularity of the Internet, a well-known, global network of cooperative
interconnected computer networks, combined with the widespread availability of
low-cost broadband networking and advanced digital compression techniques, has
spurred the growth of what is known as interactive television. Interactive
television provides viewers with compelling Internet and video content on their
25 home television equipped only with a simple internet-television terminal, such as
those pioneered by WebTV Networks, Inc. WebTV terminals are akin to the set-
top boxes associated with a cable television network, and work in conjunction with
a standard home television set to display both Internet and traditional television

content, so that persons without access to a personal computer are able to access the Internet.

The ability to combine video content with the interactive features of interactive television has spawned numerous providers of video-on-demand applications for interactive entertainment systems. Currently, the typical video-on-demand application for interactive television consists of plural video-on-demand clients on terminals attached to the viewer's home television, and one or more video-on-demand servers connected to the video head-end. The user interface of current video-on-demand applications is contained entirely in the video-on-demand client, and provides commands to the video-on-demand server to select, start or stop and pay for the video played on the viewer's home television. Typically, the video-on-demand server provides access to the video content available for transmission, whereas the client controls the selection of the video and the payment mechanism.

There are several different brands of video-on-demand applications available on the market today. Three examples are Seachange, Vivid and Microsoft's Netshow Theater. In view of the popularity of the video-on-demand feature of interactive television, there will likely be many more video-on-demand servers developed in the near future.

One of the difficulties with the proliferation of competing video-on-demand applications is the lack of an industry standard communications protocol. The protocol controls the communication between the video-on-demand server and the various video-on-demand clients on the interactive television network. The challenge in a video-on-demand application is that it must be capable of managing not only the download of digital video data to the client, but also the transmission of control data to and from the client relating to system administration (e.g. channel assignment data, billing information, etc.).

Currently, most video-on-demand servers use a proprietary communications protocol unique to that video-on-demand server. Problems arise when the protocols used to control the video-on-demand servers aren't understood (are incompatible with) the protocols supported by the various video-on-demand clients.

5 Examples of some of the diverse protocols in use today are DAVEC (a cable modem standard), DSMTC (used by certain video head-ends), and RTSP (an industry-proposed standard that has met with little success). The use of incompatible protocols has limited expansion options available to existing video on demand systems.

10 Moreover, the current configuration of most interactive video systems provide incomplete failover recoverability since the back-end servers on which most video-on-demand servers reside necessarily cannot completely manage their own failure.

Current video-on-demand servers use a limiting "segmented channel" model
15 to transmit the video data. Under this model, each viewer is assigned a dedicated video channel. This greatly limits flexibility and expansion options.

Various embodiments of the present invention redress these and other shortcomings of the prior art by interposing a middle tier in the interactive video system. This middle tier -- commonly a proxy server -- provides various services,
20 including protocol translation, system administration (dynamic channel assignment, load distribution, and failover), dynamic error-patching, and security.

According to one aspect, the invention provides an improved system and method for delivering a video-on-demand feature to remote clients of an interactive television network. The system and method employ the proxy server to
25 reconfigure the components of a video-on-demand application into a flexible multi-tiered configuration, and to redistribute the functions of those components to the proxy server so as to enhance the performance, reliability, security, scalability and other features of the system.

One implementation of the present invention includes one or more proxy servers interposed between one or more video-on-demand servers and one or more video-on-demand clients. The proxy server includes a protocol translation component, a user interface component, a channel management component, a loadsharing component, a failover component and a security component.

The translation component translates, if necessary, the communication protocols used by the video-on-demand server and video-on-demand client, and fixes -- on-the-fly -- certain errors in those protocols. The user interface component distributes the user interface between the video-on-demand server and video-on-demand client and provides user interface enhancements. The channel management component manages the assignment of transmission channels to video-on-demand clients. The failover component redirects requests to failed video-on-demand servers to secondary/alternate servers. The loadsharing component manages the load between the video-on-demand servers and possibly one or more other proxy servers in a given server configuration of the interactive television network at the head-end. The security component provides a uniform security framework that previously was located in each individual video-on-demand server at the head-end.

In one implementation of the method and system, a promotional component is also provided to initiate delivery of customized promotional content from the proxy server to the video-on-demand client.

The foregoing and other features and advantages of the present invention will be more readily apparent from the following detailed description, which proceeds with reference to the accompanying drawings.

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Brief Description of the Drawings

Figure 1 is a block diagram of an interactive video system that can be used in accordance with the present invention.

Figure 2 is a block diagram of the entertainment video head-end of Figure 1.

Figure 3 is a block diagram of video-on-demand components.

Figure 4 is a block diagram of a configuration of a video-on-demand application.

5 Figure 5 is a block diagram of a proxy server of Figure 1.

Detailed Description

Referring to Figure 1, an exemplary interactive entertainment system 10 according to one embodiment of the present invention includes an entertainment 10 head-end 12, one or more proxy servers 24, and one or more client terminals 14 intercoupled through a network 16. The proxy servers 24 are computers interposed in a middle tier between the head-end 12 and the client terminals 14 to perform various interactive video system control and user interface (UI) functions.

The network 16 typically comprises coaxial cable or optical fiber 18, 15 extending from the head-end 12 to distribution nodes 20 within various neighborhoods. From the distribution nodes, further cables 22 couple to individual subscriber premises.

The proxy server 24 is interposed in a logical TCP/IP control channel 27 between the head-end and clients. While the control signals and the entertainment 20 are physically conveyed on the same cable 18, they are shown separately in Fig. 1 for conceptual clarity.

As shown in Figure 2, the entertainment head-end 12 includes the components typically associated with a cable television head-end installation, e.g. satellite receivers 26 for receiving satellite broadcasts and producing corresponding 25 baseband analog video signals. Additionally, head-end 12 includes fast digital disk arrays and/or optical storage 28 for storage of MPEG-encoded digital video for on-demand delivery. Head-end 12 also includes one or more interactive services servers 30, which output HTML-based programming (e.g. customized news,

celebrity chat, interactive jukebox, and interactive games), as further detailed in the related applications by White et al.

The illustrated head-end 12 is shown as including the proxy servers 24. In some implementations, such servers are co-located at the head-end; in others, the 5 proxy servers are remote from the head-end.

The transmission of the various forms of data from head-end 12 over the network 16 is straightforward. As is familiar to those skilled in the video arts, the analog video is commonly distributed on 6 MHz channels, beginning at 52 MHz and extending upwardly. The digital video can be encoded on a carrier for 10 transmission within one of these conventional broadcast channels, or can be modulated at one or more other unused frequencies. Statistical multiplexing is desirably employed to transmit plural channels of digitized video with reduced bandwidth. The HTML-based interactive services and the control data can be transmitted using a conventional protocol (e.g. TCP/IP) and modulated onto a 15 suitable carrier frequency for distribution over the network. After modulation to appropriate distribution frequencies by modulators 34, these various signals are combined by an RF combiner 36 for distribution over the network 16.

Referring to the top portion of Figure 3, a typical prior art video-on-demand system includes a client terminal 14 intercoupled to a video-on-demand server 30 20 in head-end 12 through a network 16. The client terminal 14 includes a client user interface (UI) 56 to perform various interactive video system control functions, such as video selection, start, stop and payment. The video-on-demand back-end server 30 is a computer, usually co-located with the interactive services server 30, and may include a failover component 70, a loadsharing component 74 and a 25 security component 76 to perform various interactive video system control functions such as receiving and transmitting control data relating to system administration (e.g. channel assignment data, billing information, etc.), error recovery and load management.

Referring to the bottom portion of Figure 3, the illustrated implementation of the present invention interposes a proxy server 24 between the client terminal 14 and the video-on-demand server 30. In the new configuration the UI function is now shared between the client UI 56 on the client terminal 14 and the server UI 5 78 on the proxy server 24. The video-on-demand back-end server 30 no longer contains the failover component 70, loadsharing component 74 or security component 76. Those functions have been distributed instead to the proxy server 24.

The top portion of Fig. 4 shows another representation of a prior art video-on-demand system, and the lower portion shows an embodiment of the present invention. As is familiar to those skilled in the relevant arts, a security firewall 80 is commonly provided to limit access to the video-on-demand back-end servers 30 (the bi-directional control data 82 is typically transmitted over an unsecured IP link).

15 Focusing on the bottom portion of Figure 4, the illustrated embodiment interposes the proxy server 24 between the client 14 and the video-on-demand back-end server 30. The introduction of the proxy server 24 greatly enhances the configurability of the interactive video system. The back-end servers still transmit the MPEG encoded video data 84 directly to the RF combiners 36. But by
20 separately managing the control data 82 flowing between the clients 14 and multiple back end servers 30, the proxy server 24 serves as an additional security layer -- insulating the back end video-on-demand servers 30 from the IP link over which the control data 82 is transmitted. Configured in this way, the back-end video-on-demand servers 30 may be used more as a commodity available to one or
25 more proxy servers 24 in the transmission of MPEG encoded video data 84 from the back-end server 30 to the client terminal 14.

Moreover, the proxy server 24 can perform various administrative management functions, such as managing channel assignments for video-on-demand transmission.

Here a distinction should be drawn between two types of "channels." The first, termed a "transmission channel," refers to an actual frequency channel (e.g. 52 - 58 MHz) that is used to relay programming from the head-end 12 to the client terminal 14 over the network 16. The second, termed a "viewer channel," refers to the moniker (e.g. MSNBC, CNN, GAME, CHAT, VIDEO) by which a user distinguishes different programming. The mapping between viewer and transmission channels is determined by the system, e.g. proxy server 24.

The VIDEO channel is a viewer channel -- it is the channel to which the viewer switches to receive video-on-demand programming. The frequency over which this programming is delivered is not important to the viewer. Different transmission channels may be available for use at different times, depending on system resource usage (e.g. other viewers' video-on-demand usage). One day the 108-114 MHz transmission channel might be used to relay on-demand video to a subscriber. The next day, the 114-120 MHz transmission channel might be used instead. Data indicating the assignment of transmission channels-to-viewer channels is periodically sent as control data 82 between the proxy server 24 and the client terminal 14.

If a viewer interrupts delivery of an on-demand video, e.g. by switching to another channel or pressing STOP on a control panel (as further detailed in the related application by White et al), transmission of the video is suspended. The proxy maintains the assignment of the original transmission channel to that client briefly, but if the video is not promptly resumed, that transmission channel is returned by the proxy server 24 to a pool of available transmission channels. If the viewer thereafter returns to the VIDEO channel (or presses PLAY on a control panel), this fact is communicated to the proxy server 24 by the client terminal over

the control data link. The proxy server 24 then identifies an available transmission channel and instructs the client terminal 14 to tune to that channel. (This retuning is transparent to the viewer, whose channel selection remains at the VIDEO viewer channel.) The proxy server 24 similarly instructs the video server 30 to resume
5 transmission of the requested video from the point of interruption, or just before the point of interruption (for purposes of viewing context), this time modulating it on the newly-assigned channel. Video delivery resumes. However, unknown to the viewer, the video delivery resumes on a transmission frequency different than that originally used.

10 In addition to managing system resources such as transmission channels, the proxy server 24 also serves as a convenient control point for administering certain UI functions on the client terminals 14. Thus, for example, a video-selection UI by which a viewer selects a desired video from a library of available
15 videos can be defined at the proxy server 24 (which is in constant communication with the back end server's video library data), and distributed to the clients 14 as needed. (These UI elements at the proxy server include HTML instructions that are sent to the client for rendering to produce the desired user interface screens and controls.)

Similarly, by controlling from the proxy server certain client UI elements (e.g.
20 buttons, controls, graphics, labels, and other screen customizations presented to the viewer on the client terminal), it is possible to update the UI elements with new features, or to apply changes to reflect new promotional features or different branding, as needed. For example, the logo of a particular video-on-demand server may appear on a button on a UI screen presented to a viewer. The server UI 78 of
25 the proxy server 24 can dynamically change that logo as it appears on the various client terminals 14 to reflect the branding of the various video-on-demand back-end servers 30 it controls.

In contrast, primitives defining other UIs are maintained at the client terminal 14. An example is a video playback UI, with PLAY, STOP, REWIND, etc., buttons. This UI is well defined and static, so there is less advantage to distributing its definition out to the proxy server.

5 A viewer operating the client terminal 14 is unaware of the origin of the UIs presented on the viewing screen. The viewer may invoke a video playback UI (originating at the client terminal) to stop playback of an on-demand video. After pressing STOP, the system may immediately present a further UI (originating at the proxy server) indicating that the viewer has electronic mail waiting, or indicating
10 the time-remaining in the interrupted video.

Another function of the illustrated proxy server 24 is to effect protocol translation between the protocol employed by the client, and that employed by the server. As noted, there are a wide variety of such protocols. While new video-on-demand systems are commonly installed with a consistent client/server protocol,
15 subsequent events can lead to changes. For example, by acquisition or otherwise, an operator of a video-on-demand system may inherit client terminals from another (non-compatible) system. The provision of protocol translation in the proxy server facilitates integration of such non-compatible client terminals into the system. Similarly, upgrades to a video-on-demand system may entail substitution of a video
20 server employing a different control protocol. Again, protocol translation by the proxy server facilitates integration of such new equipment.

Still another function of illustrated proxy server 24 is loadsharing and failover administration. In the loadsharing component 74, the proxy server 24 monitors the loads on the various video-on-demand back-end servers 30 under its
25 control, and allocates the video-on-demand viewing load accordingly. (In an exemplary embodiment, the head-end includes several video servers. Currently popular movie titles may be replicated in several of the servers to accommodate

their expected high demand. Older, classic films, in contrast, may be present on just one server.)

Loadsharing 74 works in conjunction with the failover 70 function, where the proxy server 24 redirects requests to failed back-end servers 30 to other 5 available servers. In this way, the proxy server 24 enhances performance by managing what would likely be a catastrophic failure in the prior art configuration of video entertainment systems 10.

Yet another function of the illustrated proxy server 24 is to fix -- on-the-fly -- certain problems associated with either a client or a server. For example, a certain 10 client may, in a particular circumstance, erroneously send two PLAY commands when only one should be sent. The proxy server can be programmed to look for such aberrant behavior, and pass on to the video server only a single PLAY command. Similarly, a video server may have a bug in a JPEG compression routine that causes certain image data transmitted from the server to be flawed, prompting 15 a receiving client to fail. The proxy server can monitor the traffic from the server for such corrupted JPEG data, and can correct it before passing same to the client. (It will be recognized that this general capability is widely applicable, and is not limited to the particular bug-fixes given in these examples.)

Fig. 5 is a block diagram of an exemplary proxy server 24. The illustrated 20 server includes a CPU 38, RAM memory 40, non-volatile memory 42, a user interface (UI) 78, and appropriate interfaces to the RF combiners 36 and back-end video-on-demand servers 30.

The CPU 38 can be any of several microprocessors, e.g. those available from Intel, AMD, Cyrix, Motorola, etc. Alternatively, the CPU 38 can be a custom 25 device that optionally integrates one or more of the other components of proxy server 24.

The RAM memory 40 typically comprises 256K of EDO memory, but more or less memory, and/or memory of differing type, can alternatively be used.

The non-volatile memory 42 in the illustrated embodiment includes a ROM, EEPROM, or flash memory in which certain components of the server's operating system and applications software are stored. Additionally, the illustrated non-volatile memory 42 includes 4GB of magnetic disk storage. Software stored in this non-volatile memory (commonly transferred to the RAM memory for execution) causes the proxy server 24 to perform the various functions detailed earlier. (Such programming is well within the capabilities of artisans in this field, so is not belabored.)

Having described and illustrated the principles of our invention with reference to a preferred embodiment and various alternatives, it should be apparent that the invention is not limited to the detailed arrangements.

For example, while the detailed proxy server 24 performed a certain set of functions, in other embodiments such a server can perform a subset (or superset) of these functions.

15 While the disclosure particularly detailed the proxy server's 24 role in defining aspects of a visual UI presented on the client terminal 14, in other embodiments, the proxy can play a similar role with UIs of other types (e.g. gesture-interfaces, audio interfaces, tactile interfaces, etc.).

Reference was made to HTML. This term is meant to include not just Hypertext Markup Language per se, but also to encompass other graphical and/or video representation systems by which primitives can be combined to yield desired static or moving displays.

The illustrated embodiment employed a wired link to the interactive network, but other distribution arrangements (e.g. direct satellite broadcast, with telephone return channel) can likewise be used. Similarly, the dial-up link is not exclusive; other arrangements (e.g. MetroCOM, etc.) can be used, depending on the needs of the particular application.

Moreover, even a "wired" link to the interactive network needn't be of the sort particularly illustrated. With enhanced compression techniques and delivery technologies, other arrangements -- including plain old telephone service -- can alternatively be employed.

5 To provide a comprehensive disclosure without unduly lengthening this specification, applicants incorporate by reference the disclosure of patent 5,648,824, which discloses additional details related to video-on-demand systems and related user interfaces.

While the foregoing discussion has detailed a complete system, it employs
10 many inventive concepts -- each of which is believed patentable apart from the system as a whole.

In view of the many different embodiments to which the above-described inventive concepts may be applied, it should be recognized that the detailed
15 our invention. Rather, we claim as our invention all such modifications as come within the scope and spirit of the following claims, and equivalents thereto.